# Customer Data Access

## NARUC Webinar

**Planned for February 14, 2012**

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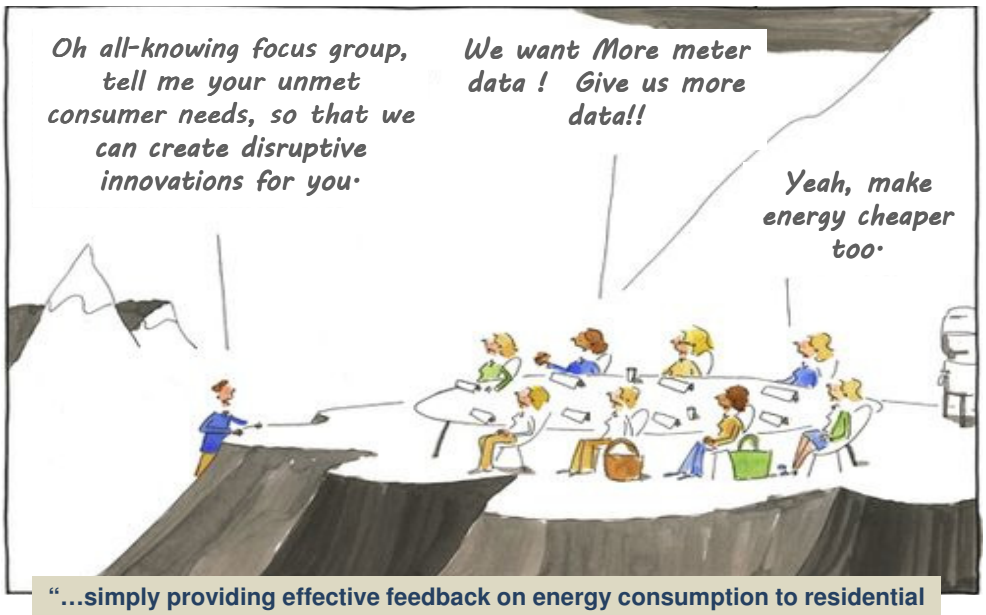
**Lawrence Berkeley National Laboratory**

## Webinar Objectives

1. What is “data access” and how can it be structured to provide the “feedback” to support short and long-term changes in customer energy usage?
2. What guidance does prior research or experience provide in answering this first question?
3. What are the technology options to support residential and small commercial customer data access;
   a) Are there technical problems ?
   b) Is there too much focus on meter data?
   c) What are the options?

# What information do customers need ?




**"…simply providing effective feedback on energy consumption to residential consumers can reduce their overall electricity use by 4% to 15%"[16]**

# Pop Quiz.

**True or False**

- ☐ In home displays (IHD's) are the most important vehicle for providing customers with data access.
- ☐ Customers provided with IHD's have been shown to reduce energy use 5% to 15%.
- ☐ Residential customers with access to near real-time meter data reduce usage more than customers with next day access.
- ☐ Studies have shown that the rate, bill design, and frequency of billing influence IHD impacts.

# Pop Quiz: Answers

**True or False**

| | | |
|---|---|---|
| ? | In home displays (IHD's) are the most important vehicle for providing customers with data access. | **We are not aware of any studies that have examined this issue.** |
| TF | Studies show that customers with IHD's have been shown to reduce energy use 5% to 15%. | **Multiple studies report this finding, however with few exceptions, most research is short-term and anecdotal.** |
| ? | Residential customers with access to near real-time meter data reduce usage more than customers with next day access. | **Few studies and questionable results.** |
| F | Studies have shown that the rate, bill design, and frequency of billing influence IHD impacts. | **We are not aware of any studies that have looked at these variables.** |

# Why is Customer Data Access Important?

**Customer education and engagement is critical to achieve smart grid efficiency, demand response, and renewable integration benefits.**

- Prior research and existing pilots emphasize short-term behavior change by focusing on meter data access and in-home displays.
- Feedback to address the long-term infrastructure changes and investment necessary to make major, permanent changes in usage is not being addressed.
- The emphasis on short-term feedback creates unreasonable expectations and misdirects policy regarding hardware investment and customer education.

# What is Customer Data Access ?

## The Purpose of Customer Data Access is to Provide Feedback

"… feedback is proving a critical first step in engaging and empowering consumers to thoughtfully manage their energy resources." [1]

"Feedback ….making energy more visible and more amenable to understanding and control.[6]

# Why is feedback important ?

- "Smart meters have no value to the customer and the customer knows that". (1)
- "The general public has no idea how much they pay for electricity or how to use less, undermining the central premise of smart meters and hindering their adoption".(2)
- "..most people do not know what devices in the home consume the most or least energy, and they do not understand their electricity bill."(3)
- "…people have absolutely no clue how to go about saving energy as a result, most of their actions are not geared toward long-term, sustainable actions to lower their energy footprint.(4)

(1) Customer 'education' draws fire, Intelligent Utility Magazine, P.Carson, September 1, 2011. http://www.intelligentutility.com/article/11/09/consumer-education-draws-fire
(2) A Problem for Smart Meters: People Don't Understand Electricity, Fast Company, A.Schwartz, August 29, 2011. http://www.fastcompany.com/1776357/a-problem-for-smart-meter-projects-people-dont-understand-electricity-pricing
(3) Energy Conservation and the Consumer Dilemma, SPARK E-Newsletter, K.Ashton, January 10, 2011. http://www.fortnightly.com/exclusive.cfm?o_id=513
(4) Americans are Clueless on Saving Energy, Study Finds, greentechenterprise, K.Tweed, August 19, 2010. http://www.greentechmedia.com/articles/read/americans-are-cluless-on-saving-energy-study-finds/

# Feedback Expectations

## IHD's are the Solution

*"The research literature shows that in-home displays …achieving savings in the range of 5–15%.."* [3]

*"Consumers could cut their household electricity use as much as 12 percent …if U.S. utilities use feedback tools .."* [4]

## IHD's are not the Solution

*"The results show that the initial savings in of 7.8% after 4 months could not be sustained in the medium- to long-term. "* [5]

*Real time monitors " may not be suitable tools to decrease consumption unless homeowners are presented with more information on how to conserve or a cost incentive such as TOU pricing."* [6]

# Customer Data Access - Framework

## Feedback: Four Stages[3]

- **Data.** *"A behavior must be measured, captured, and stored. "*
- **Relevance.** *"The information must be relayed to the individual, not in the raw-data form in which it was captured but in a context that makes it emotionally resonant. "*
- **Consequence.** *"The information must illuminate one or more paths ahead. "*
- **Action.** *"There must be a clear moment when the individual can recalibrate a behavior, make a choice, and act. "*

***Key Question:***
***What approaches provide the content consistent with this framework?***

# Webinar Agenda

1. What information influences customer energy usage?
2. What does the research tell us?
   a) Research studies
   b) Ongoing pilots
3. Meter data access – problems and options.

# 1. What information influences customer energy usage

# What are you trying to accomplish?

## Customer Feedback Policy Objectives

### Behavior Change

- Program thermostat
- Turn off lights
- Shorter showers
- Fewer wash loads
- Unplug electronics

Short –term, low cost, quick decisions, real-time feedback.

Price

### Adaptation

- Plant shade trees
- Weather strip
- Install CFL lights
- Install timers
- Programmable Thermostat options

Near–term, medium cost, lengthy decisions, multiple info sources.

Automation

### Infrastructure Change

- High-efficiency appliances
- Replace windows
- Insulate walls
- Insulate ceilings
- Install Solar PV

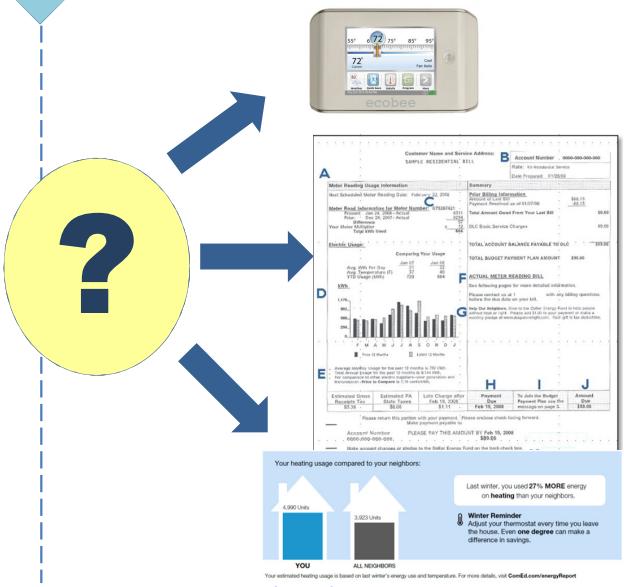
Long–term, high cost, protracted decisions, multiple info sources.

Subsidies, Incentives

# Matching Feedback to Support Customer Infrastructure Decisions

| Life in Years* | |
|---|---|
| Dishwasher | 9 |
| Dryer, Electric | 13 |
| Freezer | 11 |
| Microwave Oven | 9 |
| Range, Electric | 13 |
| Refrigerator, Standard | 13 |
| Washer | 10 |
| Water Heater, Electric | 11 |
| Air Conditioner, Room | 10 |
| Air Conditioner, Central | 15 |
| Heat Pump | 16 |

10 20




* Study of Life Expectancy of Home Components, National Association of Home Builders, February 2007, http://www.nahb.org/fileUpload_details.aspx?contentID=99359

Source: Opower, http://opower.com/uploads/library/file/15/xrds_opower.pdf

## What do customers need?

**Customers have to understand how they use energy before they can make rational decisions to improve efficiency and change their usage patterns.**

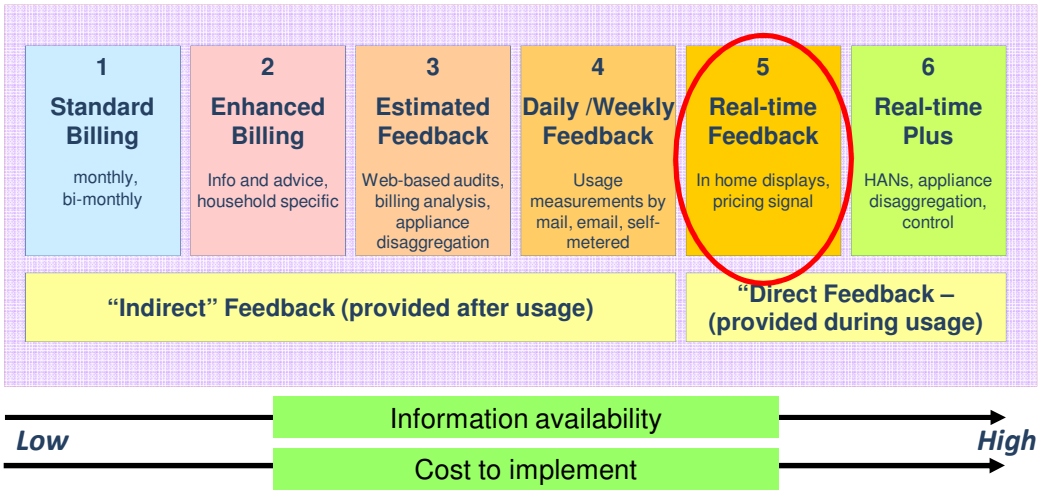
1. **What information do customers need to make rational energy decisions?** — What Information ?
2. **Which behavioral and infrastructure decisions best support the consumer value function?** — Which Decisions ?
3. **What is the best form and medium to present the information to support these decisions?** — Which Delivery Channel ?

# What to Measure

- **What to measure** – electricity, gas, water, carbon?
- **What level of measurement** – whole house or end-use?
- **What type of measurement** – real-time, near real-time, actual data, historical data, or social normative
- **What capability** – monitoring only or management too?
- **What medium** – stand alone, web, PC/phone applications?
- **What time frame** – days, months, years?
- **What information** – energy, demand, price, cost, technology availability, saving measures, other?

# EPRI: Customer Information Continuum

## EPRI Feedback Delivery Mechanism Spectrum [1]



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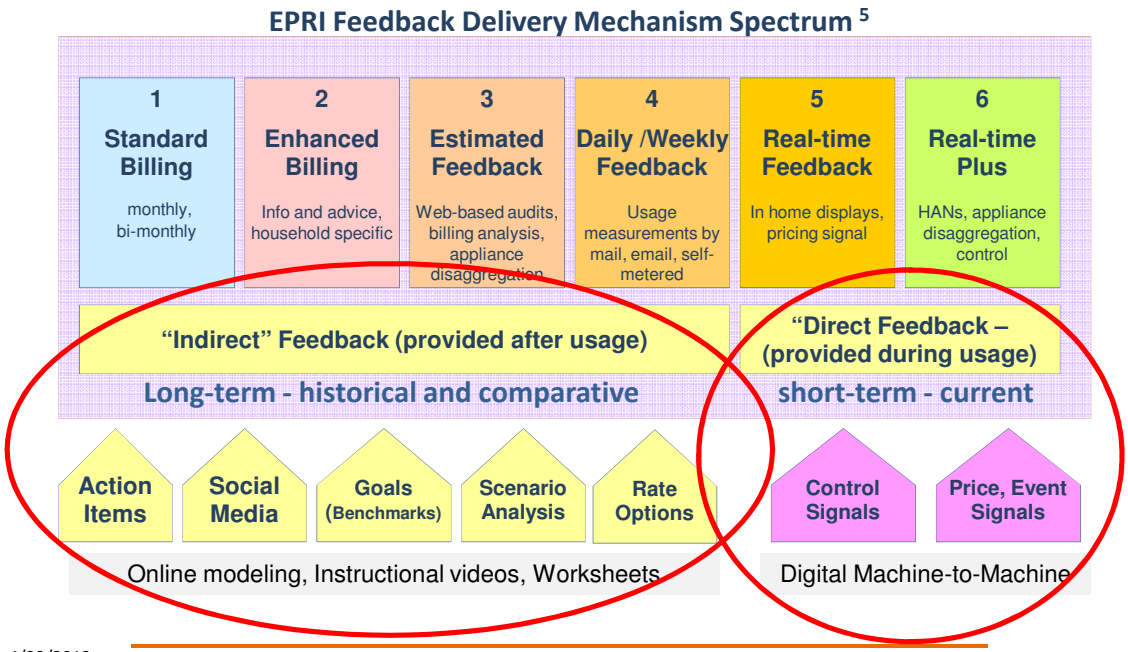


## 2. What does the research tell us?

- Meta studies
- Utility pilots

# Key Meta Studies

- **ARRA Consumer Behavior Pilots (In process)**
- **EPRI** – Residential Electricity Use Feedback: A Research Synthesis and Economic Framework (2009).[5]
- **ACEEE** – Advanced Metering Initiatives and Residential Feedback Programs: A Meta-Review for Household Electricity Saving Opportunities (2010).[1]
- **Darby** - The Effectiveness of Feedback on Energy Consumption: A Review for DEFRA of the Literature on Metering, Billing and Direct Displays (2009).[6]
- **VaasaETT [Empower Demand] -** The potential of smart meter enabled programs to increase energy and system efficiency: a mass pilot comparison (2011)[13]

# DOE-SGIG Consumer Behavior Pilots

**150,000 customers are expected to "participate" as treatment or control customers in ~10 DOE SGIG-funded projects involving AMI, dynamic pricing and consumer behavior studies**

| | Sierra Pacific | Nevada Power | OG&E | MMLD | CVPS | VEC | MN Power | CIC | SMUD | DECo | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rate Treatments** | | | | | | | | | | | |
| TOU | ● | ● | | | | | | | ● | | **3** |
| CPP | ● | ● | ● | ● | ● | | ● | | ● | ● | **8** |
| CPR | | | | | ● | | | ● | | | **2** |
| VPP | | | ● | | | ● | | | | | **2** |
| **Non-Rate Treatments** | | | | | | | | | | | |
| Education | ● | ● | | | | | | | | | **2** |
| Cust. Service | | | | | | ● | | | | | **1** |
| IHD | ● | ● | ● | | ● | ● | ● | ● | ● | ● | **9** |
| PCT | | | ● | | | | | ● | | ● | **3** |
| DLC | | | | | | | | ● | | | **1** |
| **Features** | | | | | | | | | | | |
| Bill Protection | ● | ● | ● | ● | | | | | | | **4** |
| **Experimental Design** | | | | | | | | | | | |
| Opt In | ● | ● | ● | ● | ● | ● | ● | | ● | ● | **9** |
| Opt Out | | | | | | | | ● | ● | | **2** |

# EPRI: Electricity Use Feedback[5]

"…one shortcoming of some past research is it does not impose sufficient structure on the initial sample design to test for differences in feedback effect among customers with different housing, demographic, and electricity pricing circumstances."[5]

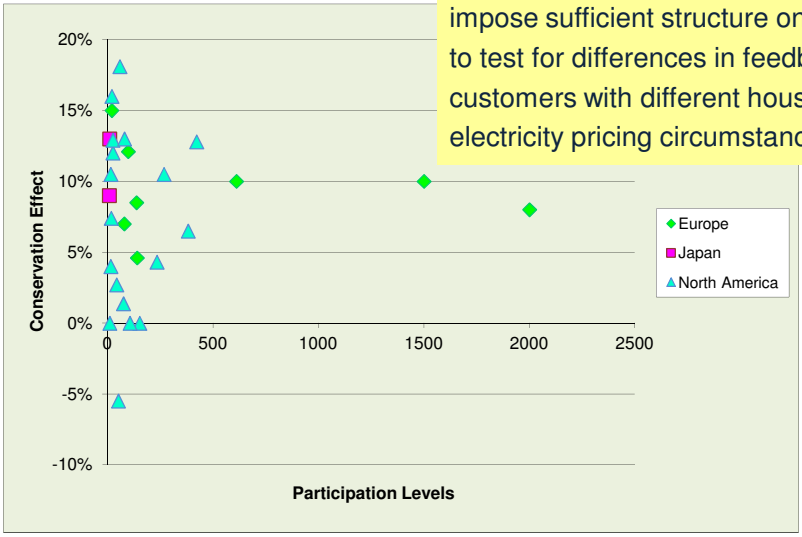
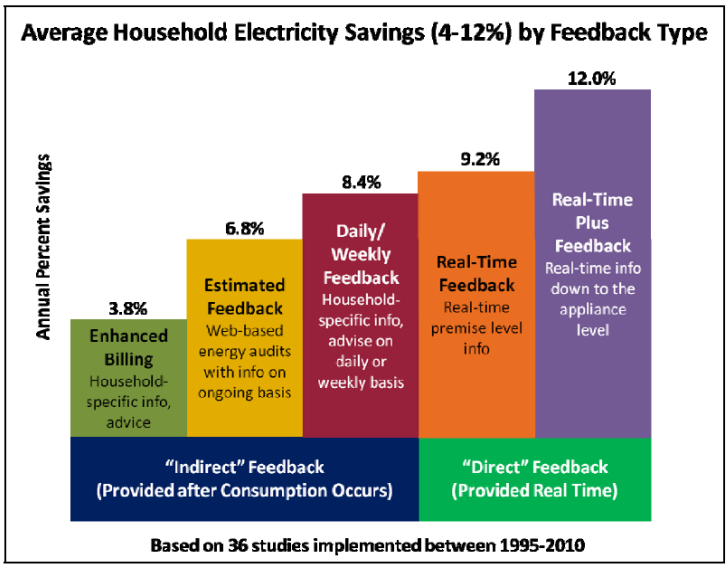



**Figure 3-1. Range of study participation levels**

# ACEEE: Feedback Effectiveness[2]

## ACEEE Meta Review




"..these estimates are dominated by studies with small sample sizes and short duration: further studies with large sample sizes and longer duration are needed before conclusions can be drawn." [2]

# Darby: Behavior Change[7]

**What do we know about measured savings from feedback studies?**

| Savings | Direct Feedback Studies N=21 | Indirect Feedback Studies N=13 | Studies 1987-2000 N=21 | Studies 1975-2000 N=38 |
|---|---|---|---|---|
| **20%+** | 3 | | 3 | 3 |
| **20% peak** | | | 1 | 3 |
| **15-19%** | 1 | 1 | 1 | 3 |
| **10-14%** | 7 | 6 | 5 | 13 |
| **5-9%** | 8 | | 6 | 9 |
| **0-4%** | 2 | 3 | 4 | 6 |
| **unknown** | | 3 | 1 | 3 |

# VaasaETT : Empower Demand [13]

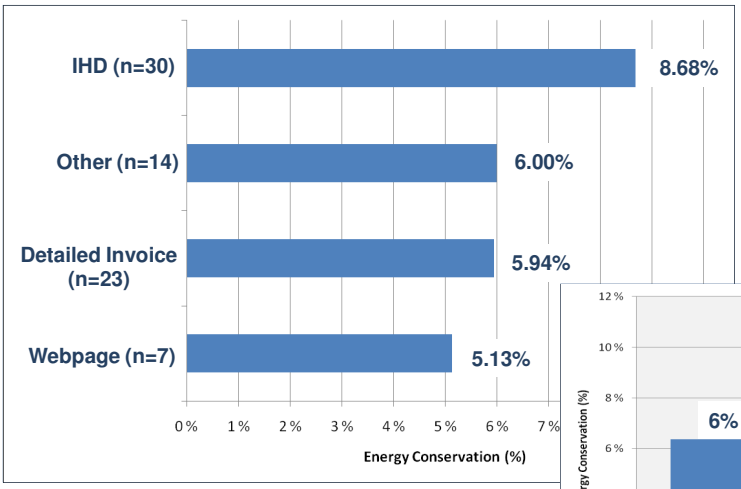
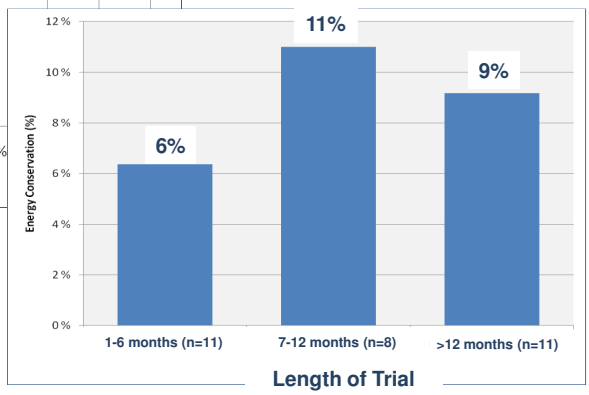
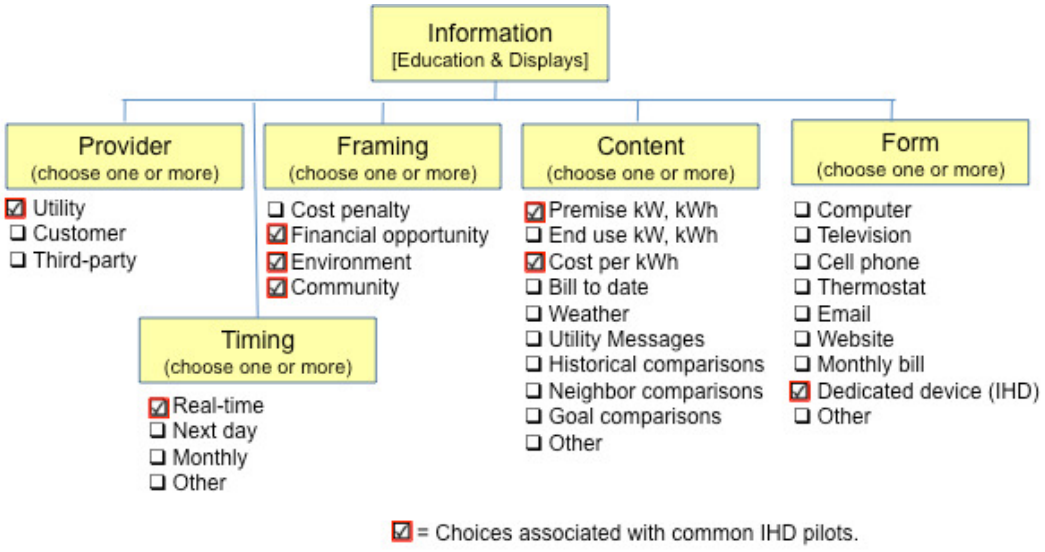



**Figure 4. Overall consumption reduction as per feedback pilot type**

**Table 12. Duration of IHD pilots and energy conservation.**



# What are the research options?




* Figure 1. Information Options, DOE Smart Grid Investment Grant, Technical Advisory Group Guidance Document #2, Non-Rate Treatments in Consumer Behavior Study Designs, August 6, 2010.

# Key Pilot Research Studies

- Commonwealth Edison
- Fischer:  Historical Feedback Studies
- Brattle:  Recent Feedback Studies
- Oklahoma Gas & Electric

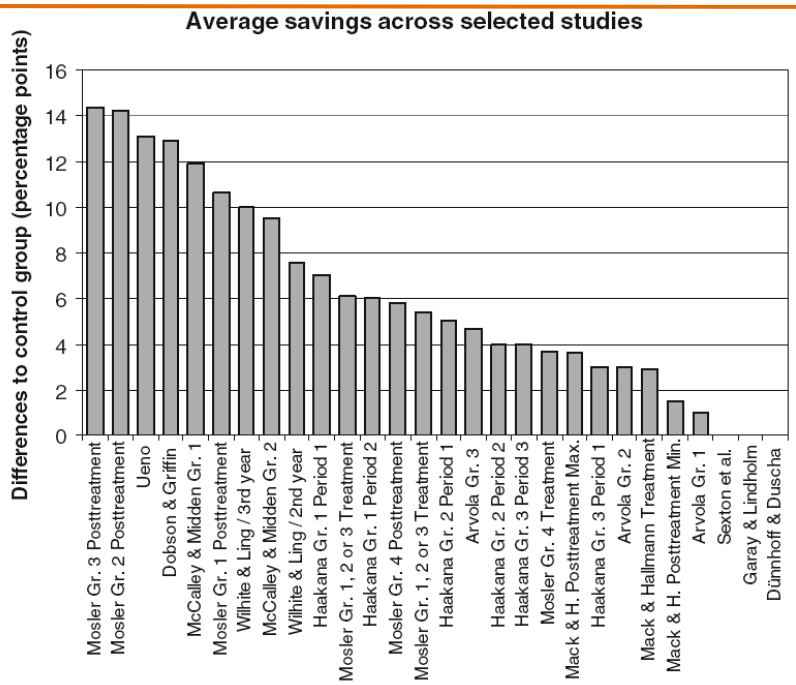
# Commonwealth Edison – Pilot Results

**Table 4-1.**
**Acquisition and Implementation of Free and Purchased Technology[4]**

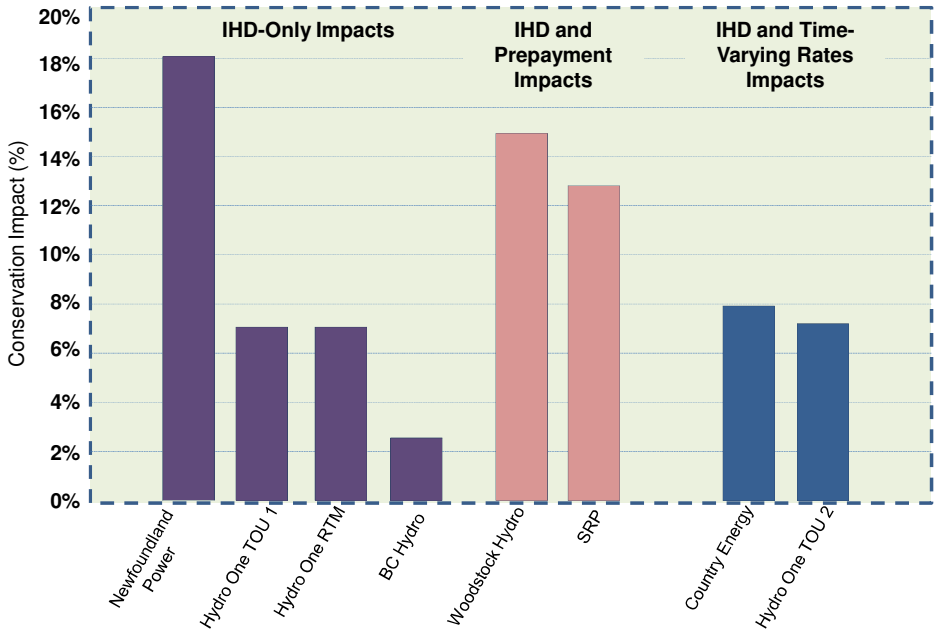
| | Numbers | | | Rates | |
|---|---|---|---|---|---|
| | Offer | Acquire | Implement | Acquire | Implement |
| **Customers Provided with Free IHD's** | | | | | |
| L5. Basic IHD | 485 | 485 | 163 | 100% | 34% |
| L6. Advanced IHD | 205 | 205 | 26 | 100% | 13% |
| **Customers Given Option to Purchase IHD's** | | | | | |
| L5b. Basic IHD | 211 | 5 | 4 | 2% | 1% |
| L6b. Advanced IHD | 205 | 4 | 4 | 2% | 1% |

Notes:
- Basic IHD: linked to meter, continuous usage with historical comparison
- Advanced IHD: combines usage data with access to data via internet, also combined with PCT, not fully described.
- For row L5 the 34% represents the number of customers provided free IHD's that actually installed and initialized the device. For row L5b, only 2% (5/211) of the customers chose to purchase an IHD and then only 80% (4/5) of those were installed. IHD usage

# Fischer: Historical Feedback Studies[9]



# Brattle: Recent Feedback Studies [12]

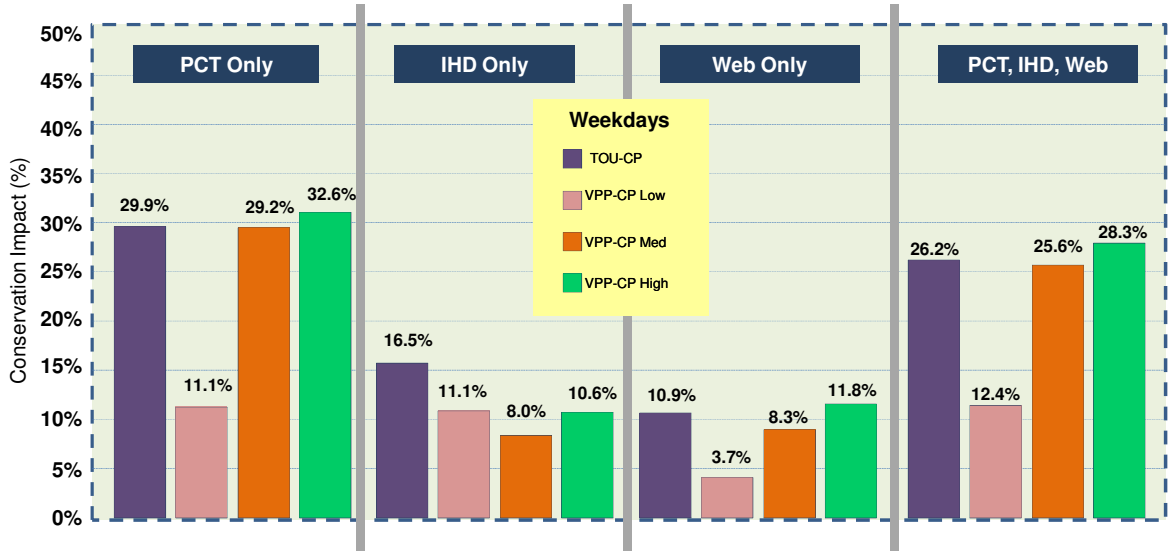


# Brattle: Recent Feedback Studies [12]

## The Bottom Line

- Customers who actively used an IHD in the pilots reduced their electricity consumption by about 7%
- When customers both used an IHD and were on some type of electricity pre-payment system, they reduced their electricity consumption by about 14%

# OG&E: 2010 Demand Response Study[17]




- ❑ Pre-assigned cells
- ❑ Online self-enrollment
- ❑ Best Bill Guarantee

## What are the issues and limitations

- Pilots focus on IHD hardware rather than information
- Rate design and pricing are ignored but essential for creating a customer value function
- Billing information is needed to reinforce the value function
- IHD's support short-term behavior change, not long-term infrastructure change
- Research is searching for a single solution where the market will probably require a dynamic mix of multiple treatments

# What policies should you consider ?

## Policy Options

| Behavioral Change | Adaptation | Infrastructure Change |
|---|---|---|
| • Data Access<br>• Understandable Rates<br>• Dispatchable Prices<br>• Clear Bills<br>----------<br>• Privacy | • Evaluation Tools<br>• Rebates<br>• Open Markets for Technology<br>• Standards | • Building Standards<br>• Appliance Standards<br>• Financial Incentives<br>• Rate design stability |

# 3. SMUD Residential Information and Controls Study

## *Project Design*

**Karen Herter, Ph.D.**

Herter Energy
RESEARCH SOLUTIONS

# Research Team and Funding

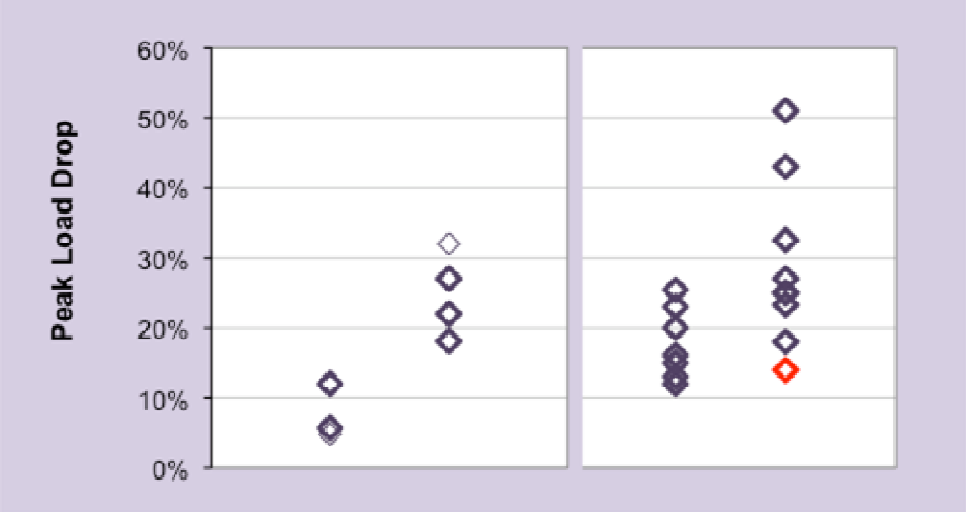
- Research Team
  - Herter Energy Research Solutions
  - Sacramento Municipal Utility District (SMUD)
- Funding
  - Sacramento Municipal Utility District (SMUD)
  - California Energy Commission Public Interest Energy Research via the Demand Response Research Center at Lawrence Berkeley Lab

# Study Goals

- Build on what we already know
  - *TOU rates* are effective for shifting load every day
  - *Dynamic rates* are effective for shedding load during events
  - *Thermostat automation* enhances both of these effects
- Answer some new questions
  - Does real-time energy data enhance energy and/or peak savings?
  - Is there added value in providing real-time appliance energy data?
- **Combine** rates, automation, real-time data and enhanced customer support to…
  - capture synergies between program variables
  - provide as realistic an experience as possible
  - define results that can be translated to the real world

# What we already know

Results of residential pricing studies in Ontario, California, Puget Sound, Florida, Australia, Illinois, Missouri, New Jersey, Maryland, Connecticut, Washington DC




**Q: Might real-time data from new smart meters provide additional value?**

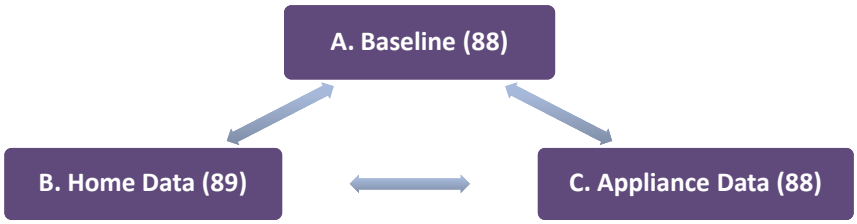
# Residential Information & Controls Study

- Phase 1: 2009 Simulation Research
  - 450+ SMUD participants
  - Simulated home environment w/ TOU-CPP rate
  - Findings
    - Home data: **No savings**
    - Appliance data: **6% savings**
- Phase 2: 2012 Summer Solutions Pilot
  - 265 residential SMUD participants
  - Equipment installations in Sacramento and Folsom
  - Treatments
    - Real-time data: **Home** vs. **Appliance**
    - Incentives: **Dynamic rate** vs. **Load**

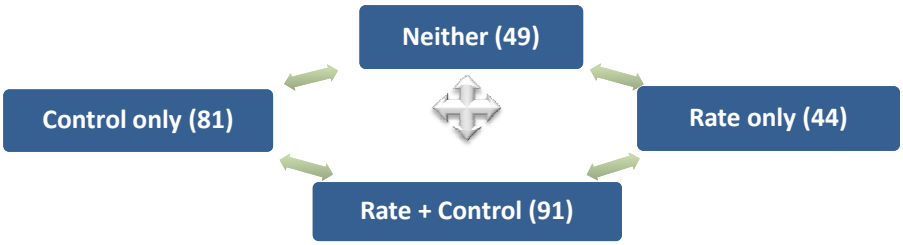
# Research Design

N=265 residential customers

**A. Information Treatments - randomly assigned**




**B. Dynamic Rate and AC Load Control - customer chosen**



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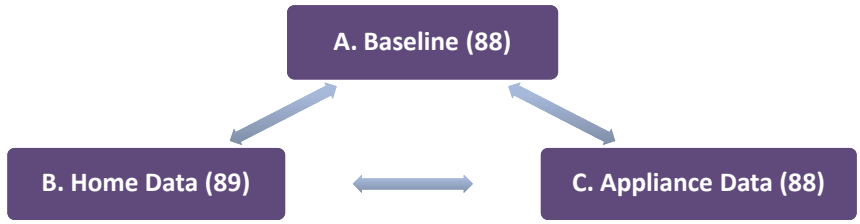


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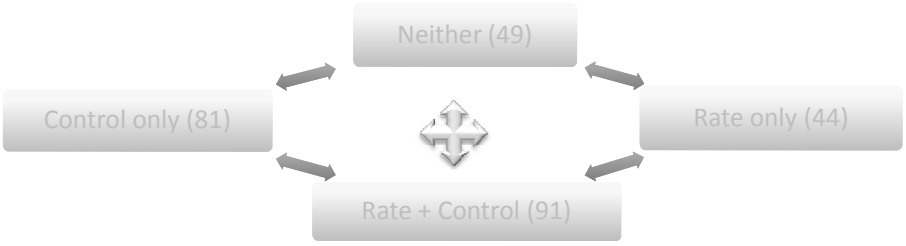
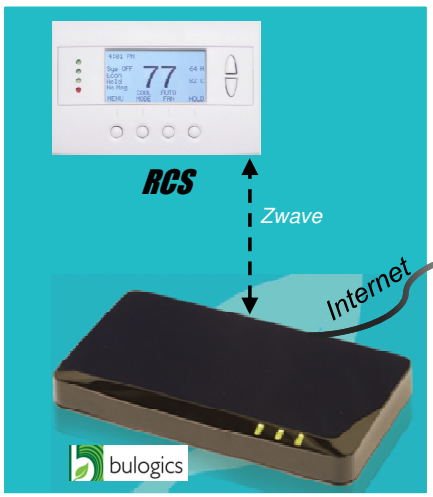
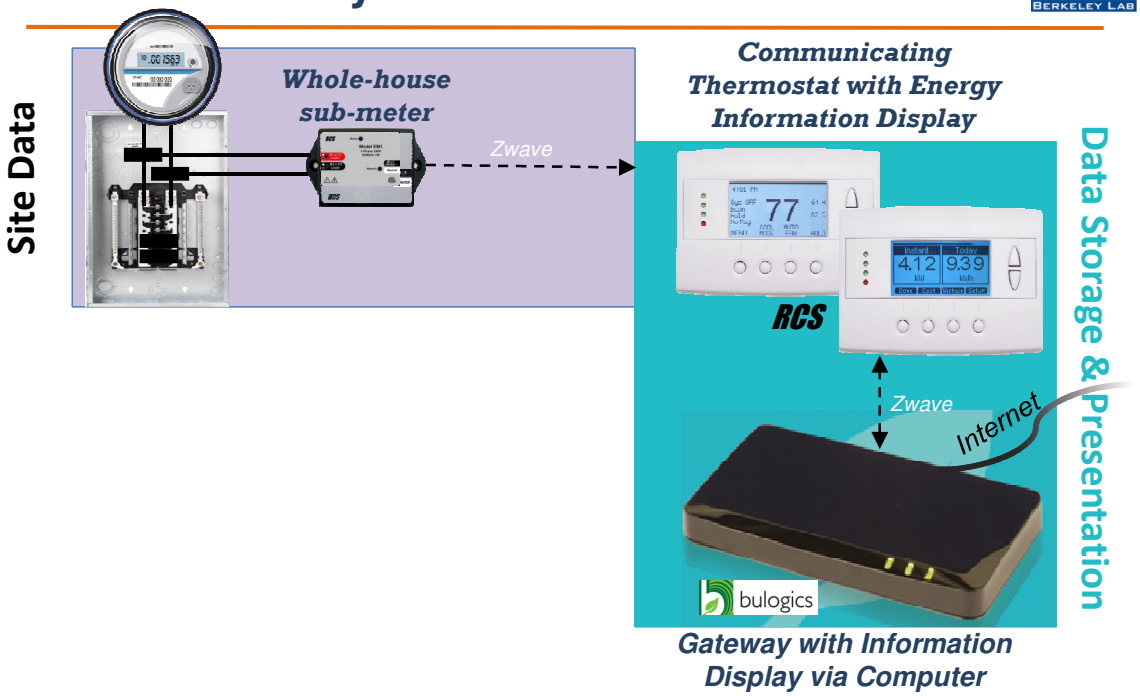


# Information System A - Baseline

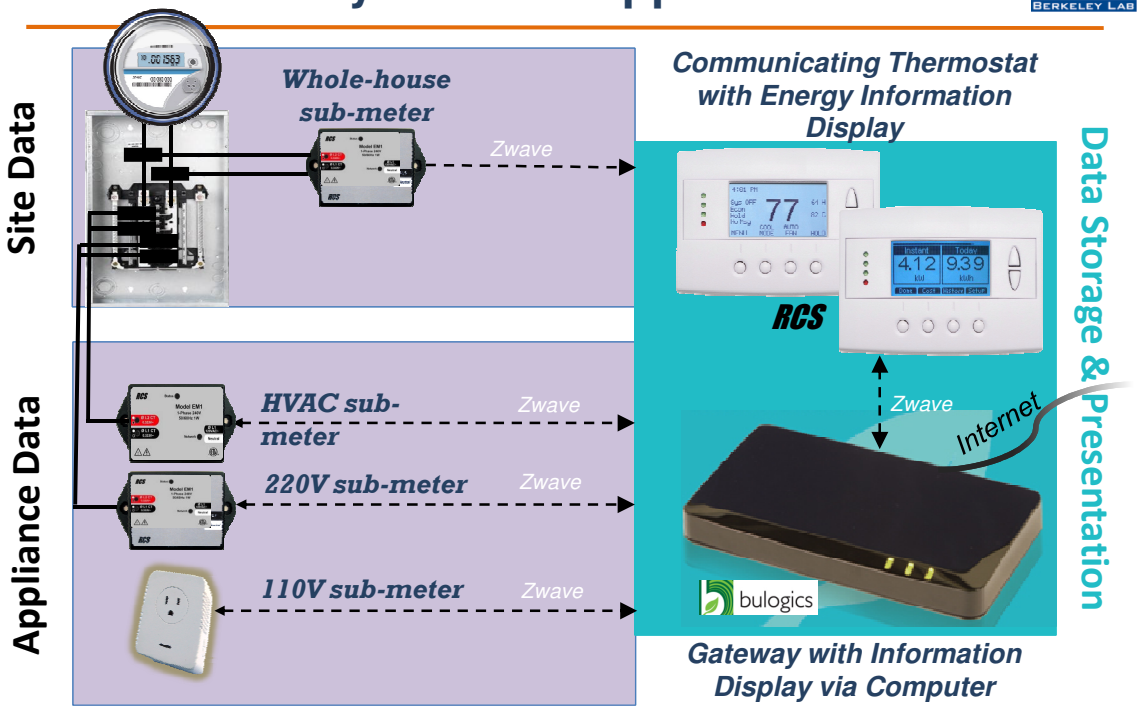



Gateway provides OpenADR event notification

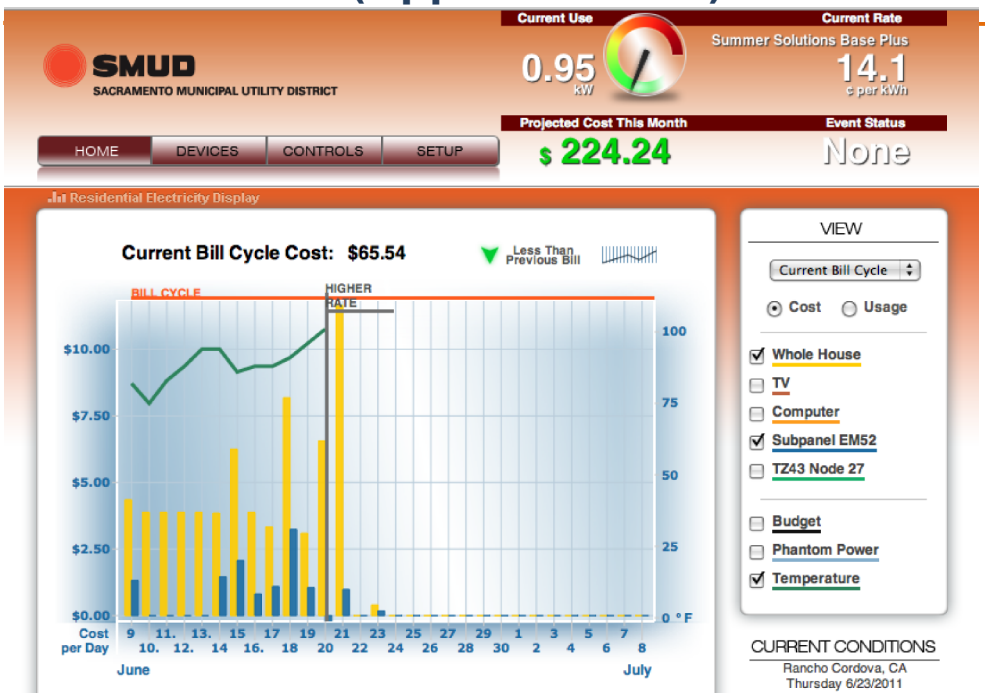
# Information System B – Home data



# Information System C – Appliance data



# User Interface (Appliance data)



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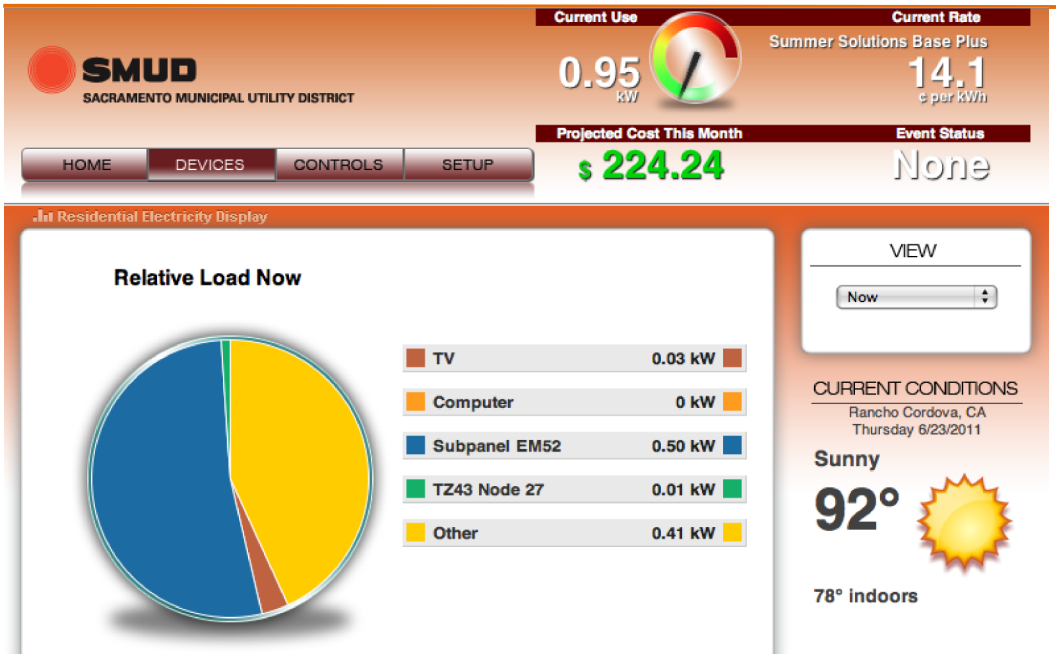

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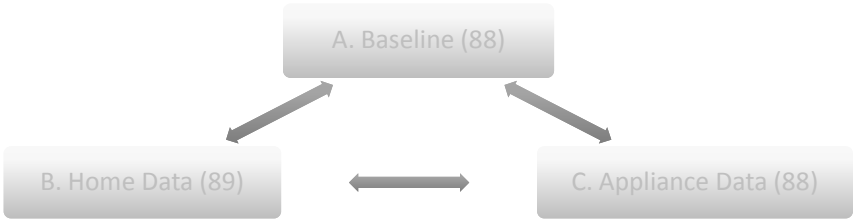


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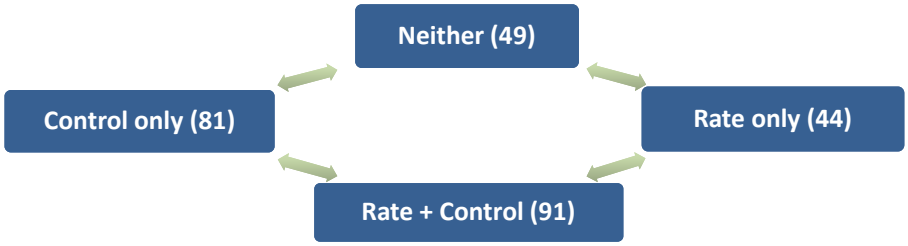
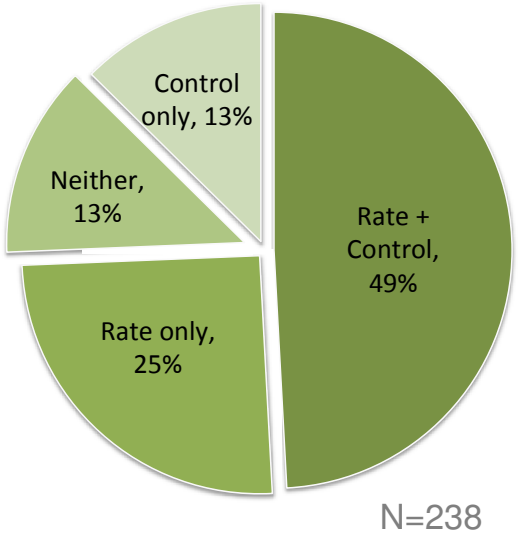


# Recruitment – Program Choices

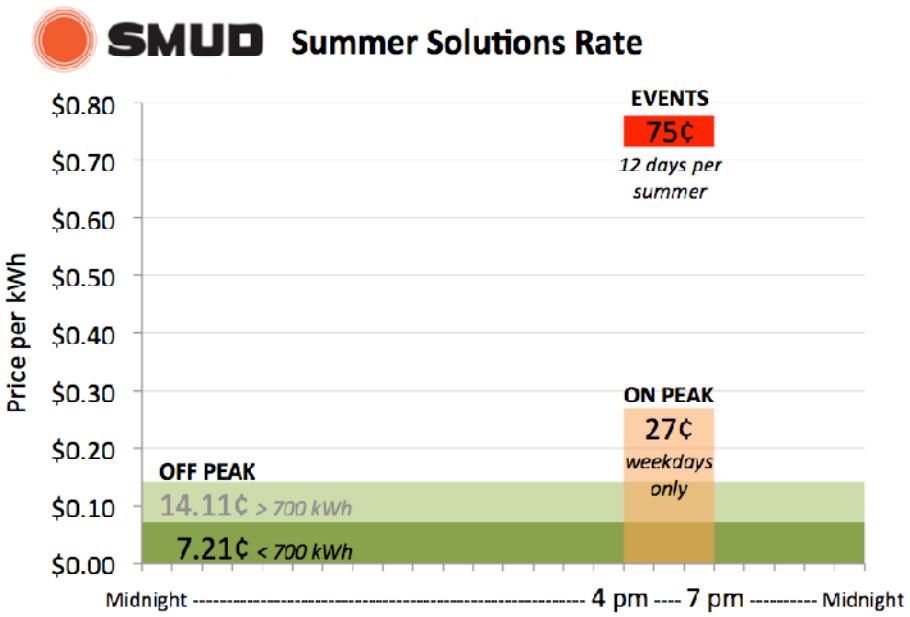
...of customers offered a dynamic Rate and/or AC Control

- Rate
  - TOU-CPP rate, a.k.a. the "Summer Solutions rate"
  - Customer determines response to high-price events
  - 12 events
- Control
  - 4° set point raise during events
  - One override allowed
  - Same 12 events as TOU-CPP rate




*All participants receive one of the three randomly assigned equipment configurations, no matter their program choices*

# Optional TOU-CPP Rate



# Hypotheses

- **For all participants**
  - Energy use is lower
  - Weekday peak demand is lower
  - Peak demand on event days is lower
  - Electricity bills are lower
- **Savings are better for customers:**
  - (a) with more information
  - (b) who chose more program options
  - (c) on the dynamic rate, compared to direct load control
  - (d) with higher energy use
  - (e) with certain self-reported behaviors
  - (f) with certain dwelling characteristics
  - (g) with certain demographic characteristics
  - (h) with higher satisfaction levels

# Hypotheses

- **For all participants**
  - Energy use is lower: **YES**
  - Weekday peak demand is lower: **YES**
  - Peak demand on event days is lower: **YES**
  - Electricity bills are lower: **YES**
- **Savings are better for customers:**
  - (a) with more information: **MIXED**
  - (b) who chose more program options: **YES**
  - (c) on the dynamic rate, compared to direct load control: **YES**
  - (d) with higher energy use: **YES**
  - (e) with certain self-reported behaviors: **YES** (pre-cooling, peak offset)
  - (f) with certain dwelling characteristics: **YES** (swimming pools)
  - (g) with certain demographic characteristics: **NO** (age, education, income)
  - (h) with higher satisfaction levels: **MIXED** (no savings for dropouts)

# Field Test & Findings

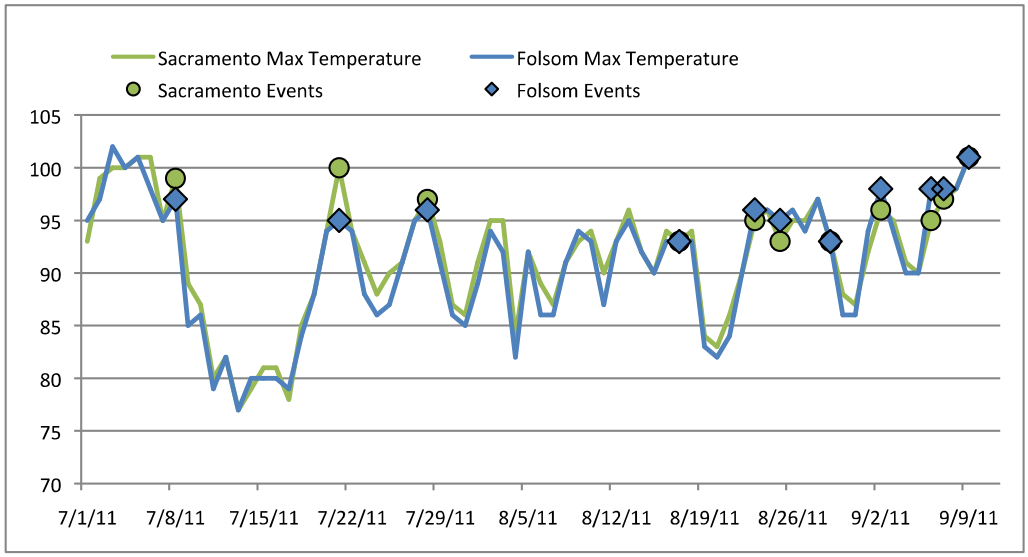
# Field Study: Education and Outreach

- Installers assisted with thermostat settings
  - Encouraged all participants to automate response to critical events
- Quick Start Guide and equipment user guides
- Websites with information, tips, discussion board
- On-site energy assessments with personalized recommendations
- Summer Solutions Rate magnet
- SS rate vs. Standard bill comparison
- 24-hour advance notification of events
  - via email, thermostats, text message, phone

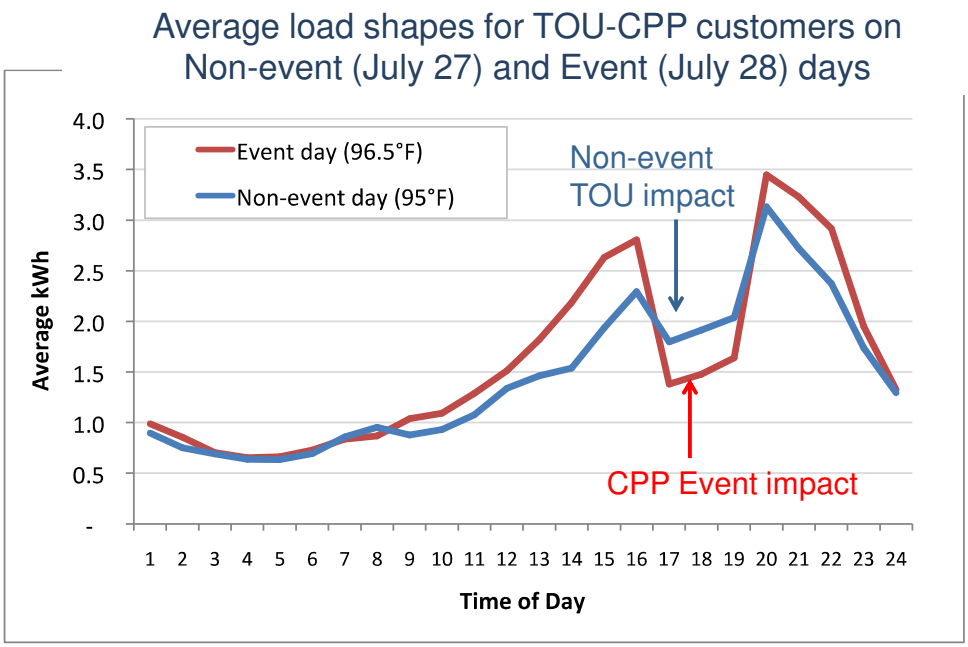
# Events - Overview

- **Twelve events from July to September**
- **Notify Participants**
  - Email – including recommendations for participant action
  - Thermostat display – blinking light and message
  - Computer energy display – ACTIVE event status displayed
  - Special requests: Phone calls or text message
- **Notify Equipment**
  - OpenADR to gateway
  - ZWave from gateway to thermostat
  - Thermostat initiates Automatic Temperature Control (4˚ F) or customer-programmed response to events

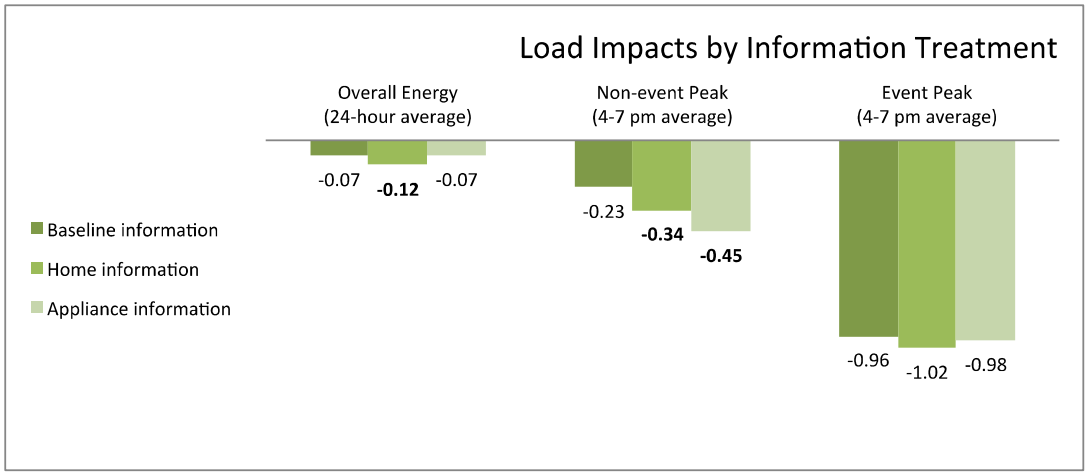
# 2011 Temperatures and Events



# Peak Impacts: TOU-CPP Rate

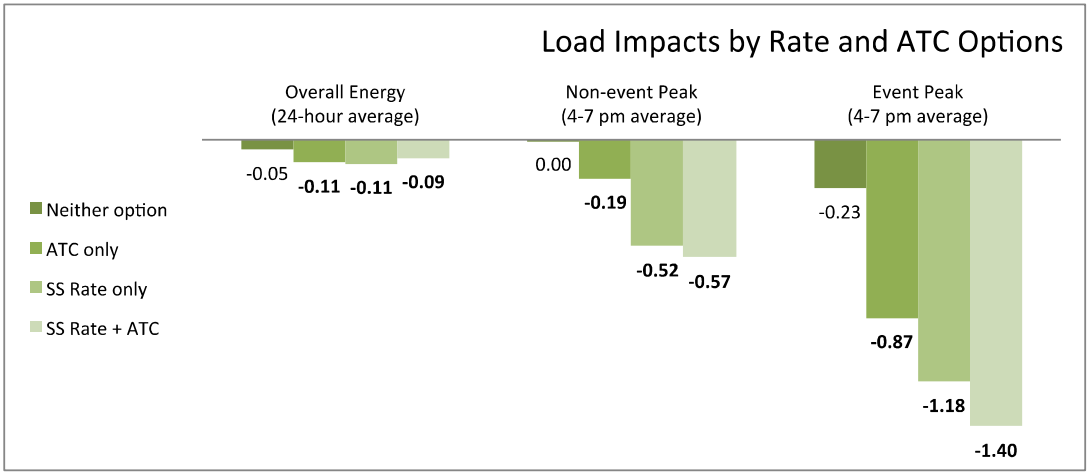


# Information Effects



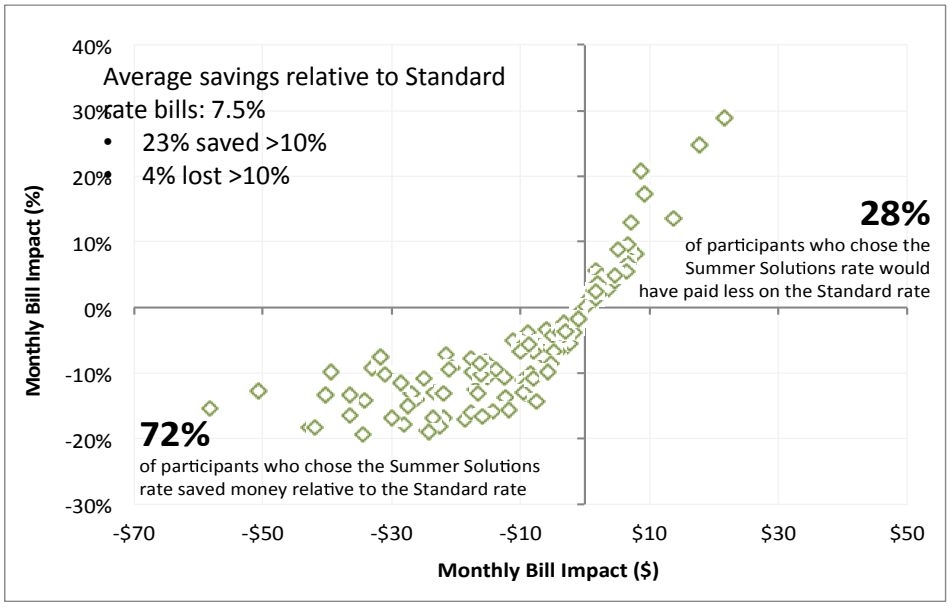

*Values in bold indicate a statistically significant difference from "Baseline information"*

# Rate and Control Effects




*Values in bold indicate a statistically significant difference from "Neither option"*

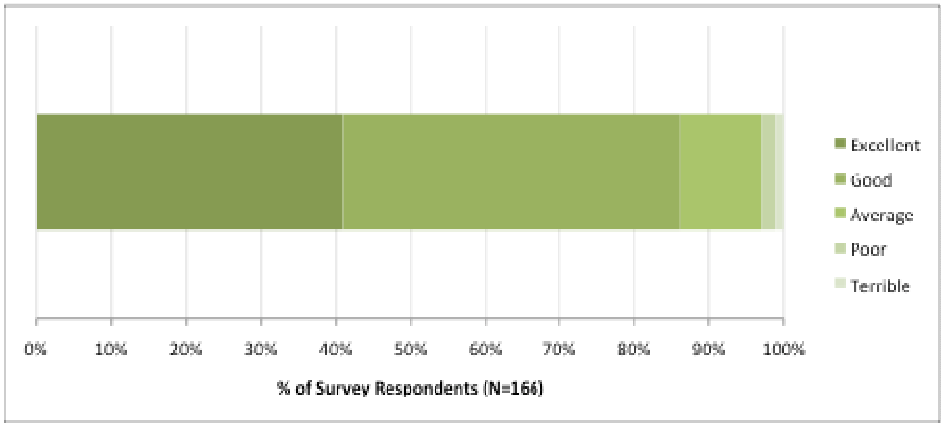
# Billing Impacts




Note: These bill savings are in addition to those associated with energy savings

# Customer Satisfaction

- 86% = Excellent or Good
  - All groups were equally satisfied
- 90% signed up again for Summer Solutions 2012
  - 5% dropped out, 5% unreachable



# Hypotheses

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  - (f) with certain dwelling characteristics: **YES** (swimming pools)
  - (g) with certain demographic characteristics: **NO** (age, education, income)
  - (h) with higher satisfaction levels: **MIXED** (no savings for dropouts)

# References - 1

| | Title | Link |
|---|---|---|
| 1 | Advanced Metering Initiatives and Residential Feedback Programs: A Meta-Review for Household Electricity-Saving Opportunities, ACEEE, Martinez, Donnelly, Laitner, June 2010 | https://www.burlingtonelectric.com/ELBO/assets/smartgrid/ACEEE%20report%20on%20smart%20grid.pdf |
| 2 | The Persistence of Feedback-Induced Energy Savings in the Residential Sector: Evidence from a Meta-Review | http://www.stanford.edu/group/peec/cgi-bin/docs/events/2010/becc/presentations/3D_KarenEhrhardt-Martinez.pdf |
| 3 | Harnessing the Power of Feedback Loops, Wired, TGoetz, June 19, 2011. | http://www.wired.com/magazine/2011/06/ff_feedbackloop/ |
| 4 | The Effect on Electricity Consumption of the Commonwealth Edison Customer Application Program Pilot: Phase 1, April 2011. | http://www.smartgridinformation.info/pdf/3273_doc_1.pdf |
| 5 | Residential Electricity Use Feedback: A Research Synthesis and Economic Framework, EPRI, Neenan, Figure 2-2, February 2009. | http://opower.com/uploads/library/file/4/residential_electricity_use_feedback.pdf |
| 6 | Exploring consumer preferences for home energy display functionality, August 2009. | http://www.cse.org.uk/pdf/consumer_preferences_for_home_energy_display.pdf |

# References - 2

| | Title | Link |
|---|---|---|
| 7 | Making it obvious: designing feedback into energy consumption, | http://www.bluelineinnovations.com/documents/makingitobvious.pdf |
| 8 | Direct Energy Feedback Technology Assessment for Southern California Edison Company, March 2006 | http://sedc-coalition.eu/wp-content/uploads/2011/05/Stein-In-Home-Displays-March-2006.pdf |
| 9 | Feedback on household electricity consumption: a tool for saving energy, Energy Efficiency, Corinna Fischer, 2008. | http://www.mendeley.com/research/feedback-household-electricity-consumption-tool-saving-energy/ |
| 10 | Some consideration on the (in)effectiveness of residential energy feedback systems, Carnegie Mellon University, August 2010 | http://www.paulos.net/papers/2010/ineffective_energy.pdf |
| 11 | U.S.Department of Energy Smart Grid Investment Grant Technical Advisory Group Guidance Document #2, Non-Rate Treatments in Consumer Behavior Study Designs, August 6, 2010. | http://www.smartgrid.gov/sites/default/files/pdfs/cbs-guidance-doc2-cbsp-outline.pdf |
| 12 | The Impact of Informational Feedback on Energy Consumption – A Survey of the Experimental Evidence, The Brattle Group, May 20, 2009 | http://www.brattle.com/_documents/uploadlibrary/upload772.pdf |

# References - 3

| | Title | Link |
|---|---|---|
| 13 | The potential of smart meter enabled programs to increase enerty and system efficiency: a mass pilot comparison, vaasa ett, October 2011 | http://www.esmig.eu/press/filestor/empower-demand-report/ |
| 14 | Energy Conservation and Carbon Reduction, Energywatch Smart Metering Seminar, S.Darby, September 2005 | http://www.powershow.com/view/fdc0b-YTM4Z/Energy_conservation_and_carbon_reduction_flash_ppt_presentation |
| 15 | The Impact of In-Home Displays on Energy Consumption, Colorado Public Service Commission, A. Faruqui, S.Serguci, June 7, 2010 | http://www.dora.state.co.us/puc/presentations/InformationMeetings/SmartGrid/06-07-10CIM_Smart-Grid_ImpactIn-homeDisplays(Brattle%20Group).pdf |
| 16 | A Policy Framework for the 21st Century Grid: Enabling Our Secure Energy Future, Executive Office of the President of the United States, June 2011, p.45. | http://www.whitehouse.gov/sites/default/files/microsites/ostp/nstc-smart-grid-june2011.pdf |
| 17 | Oklahoma Gas & Electric 2010 Demand Response Study , Interim Results & Lessons Learned, M.Farrell, March 30, 2011. | http://www.linkedin.com/news?viewArticle=&articleID=879569178&gid=2610610&type=member&item=78093355&articleURL=http%3A%2F%2Fwww%2Eraabassociates%2Eorg%2Fmain%2Froundtable%2Easp%3Fsel%3D109&urlhash=llpS&goback=%2Egde_2610610_member_78093355 |
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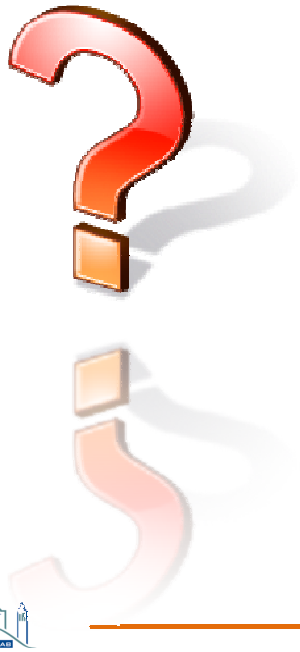
# Contact Information

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